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METHOD OF DETERMINING THE TENSION IN PRESTRESSING STRAND WITH THE VIBRA-TENSION, MODEL ET-U

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section F of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

The use of the Vibra-Tension, Model ET-U for determining the tension in prestressed, pretensioned straight or harped strands of prestressed concrete members is described in this test method. Tension is measured as a function of the fundamental frequency of a vibrating strand.

B. APPARATUS

1. Vibra-Tension, Model ET-U. This is an electronic instrument which converts the fundamental frequency of vibration of a stressed prestressing strand to tension. The Vibra-Tension uses a transducer to monitor the vibration of a prestressing strand. Two types of transducers, a contact and a non-contact, are available for use.

C. TEST PROCEDURE

1. Check the batteries prior to using the Vibra-Tension. Turn the Viber-Tension off and press the battery test buttons, one at a time. A charged battery is indicated by the tension meter pointing past the right edge of the tension scale. If the meter reads on or the left of the 5 on the top scale, then the batteries need recharging. Recharging is accomplished in the following manner:

   a. Press the "Off" button.

   b. Plug the charger cord into any 110-V 60-cycle AC outlet. The red light indicates that the batteries are being charged.

   c. Continue charging until both battery tests indicate to the right of the 5 on the top scale. Normal charging time is 6 h. Charging the instrument overnight is advised when it is to be used the next day. Electrical protective circuits in the Vibra-Tension prevent overcharging. With a full charge, the instrument has power for 4 to 6 h of continuous use. If the batteries do not respond to charging, the instrument should be returned for servicing to the Structural Materials Section of the Transportation Laboratory Branch in Sacramento.

2. Calibration: Check calibration of the Vibra-Tension whenever it has been transported by common carrier, over rough terrain, or otherwise roughly handled, and also after recharging. The calibration check

procedure is an exact point of reference and can be performed whenever necessary. The procedure is as follows:

a. Check batteries; if properly charged, proceed. If not, charge batteries before proceeding.

b. Set strand diameter setting to 305.

c. Set bridge length dial to 1.5 m.

d. Set vernier to 0.

e. Set scale selector to C.

f. Connect non-contact transducer to input jack.

g. Connect charge cord to any 60-cycle 115-V AC outlet.

h. Turn Vibra-Tension on and allow two minutes for warm-up.

i. Place non-contact transducer in instrument storage compartment so that it picks up a 60-cycle signal from the battery charger.

j. Read tension on scale C of the tension meter. It should read 4750. If reading is off, adjust to correct reading by means of adjustment screw on tension meter frame. See Figure 1.

k. Turn Vibra-Tension off.

l. To ensure that the contact transducer is working properly, both the contact and the non-contact transducers may be used to measure the same tensioned strand. Accuracy within 2% of the true strand tension may be obtained by using either steel or wooden wedges as bridges if the bridge length is greater than 8.2 m. But wooden wedges must be used for bridge lengths shorter than 8.2 m to obtain an accuracy within 2 %.

3. Bridging: Bridging is fixing two points, one at each end of a length of strand under investigation so that any movement or vibration of these points is prevented. The length of strand (bridge length) between the bridge points must be free to vibrate. Bridge points may be located at harping points, bulkheads, or at any other convenient place, and can be established by the use of steel or wooden wedges firmly placed. If a harping hold-down device which provides for strand separation is used, steel or wooden wedges may be employed to further spread individual strands apart. To facilitate bundled strand separation at the harping point, a small section of reinforcing bar can be placed near the harping point between layers of strands prior to stressing and may be left in the girder. Wooden wedges should always be removed prior to placing concrete. Usable bridge lengths for 12.7-mm diameter, 1860 MPa pre-stressing strand are 3.6 to 12 m inclusively. To ensure that accuracy within 2 % of the true strand tension is maintained, wooden wedges may be used for the entire usable bridge length range. However, steel wedges or clamps must be restricted for use for bridge lengths longer than 8.2 m to maintain a 2 % accuracy. Normally, the use of a long bridge length, between 8.2 to 12 m, results in the best accuracy.

4. Tension Measurement: The measurement procedure is as follows:

   a. Determine manufacturer, grade, and size of strand. Determine strand diameter setting and scale setting from Table 1 or, if unable to determine proper setting, contact the Structural Materials Branch of the Transportation Laboratory in Sacramento for advice. Set the strand diameter dial and scale selector to the proper settings. The scale selector is not connected to the electrical circuitry of the Vibra-Tension and should be used by the

operator only as a reminder of which scale he should read. A picture of the Vibra-Tension is shown in Figure 1.

b. Set vernier dial to zero if using the non-contact transducer. If using the contact transducer, determine the vernier setting from Table 1 and adjust the vernier knob.

c. After the strand has been tensioned, measure the bridge length to the nearest 30 mm and set this length on the bridge length dial. This measurement should be made between initial contact points of the bridge points and the strand.

d. Turn instrument on and allow two minutes for warm-up.

e. Plug either transducer into the input jack.

f. Locate transducer in the center $^1/_4$ span, preferably at the center of the bridge length. If using the non-contact transducer, make sure the vernier dial is set on "0", then position the transducer parallel to and approximately 5 to 50 mm away from the strand as shown in Figure 2. The non-contact transducer should be held steady during readings. The contact transducer should be fastened to the strand in an upright position as shown in Figure 3, and should be placed as close to the center of the bridge length as possible.

g. Vibrate the strand by lightly tapping with the heel of the hand near the center of the bridge length.

h. The Vibra-Tension tension meter has three scales which are used as 8 overlapping scales. The top scale is used as A, D, and G scales. The center scale is used as B, E, and H scales. The bottom scale is used as C and F scales. The scales and corresponding ranges are shown below:

A	1.334	-	22.240 kN.
B	2.669	-	44.480 kN.
C	5.338	-	88.960 kN.
D	13.344	-	222.400 kN.
E	26.688	-	444.800 kN.
F	53.376	-	889.600 kN.
G	133.440	-	2224.000 kN.
H	266.880	-	4448.000 kN.

Read the strand tension from the appropriate scale after the needle has stabilized. To obtain an average value, three readings should be recorded.

i. Turn instrument off when measurements are not being made to protect batteries.

5. Troubleshooting: If the Vibra-Tension does not function properly:

a. Check batteries. Erratic readings may be caused by weak batteries.

b. Check all settings.

c. Check bridging points. Loose bridging points will emit a low-pitched buzzing sound or allow strand to vibrate on both sides of the bridging point.

d. Check transducers. If an unstable reading occurs with the contact transducer, try setting the vernier to zero and using the non-contact transducer. The non-contact transducer is less sensitive to external vibration and shock.

e. Check for vibration of forms. If the vibration induced in the strand damps out very quickly, move one or both of the bridge points to a firmer point on the form.

D. PRECAUTIONS

The Vibra-Tension is a delicate electronic instrument and should receive the same care

given to other precision instruments. Special attention should be directed to the following:

1. Handle with care to prevent dropping or other rough handling.

2. Protect against dust and moisture.

3. Store the transducers and charging cable in the storage compartment when not in use.

4. Always turn instrument off when not in use. Careful attention must be given to the bridging points as they are the most frequent source of error in making a tension measurement. If, after several attempts to obtain a stable reading you fail to do so, you should check bridging points for vibration or check to make sure nothing is touching the vibrating strand between bridging points. Vibrations of the casting bed or strands caused by workmen working in the area can affect the accuracy of the tension readings.

E. REPORTING RESULTS

Keep neat, orderly notes of all measurements and results. Record the following values: Strand manufacturer, strand tension, diameter setting, scale, vernier setting, bridge length, and transducer used. Report total length of strand, strand location in tendon, and location of bridge length (e.g., on straight strand or on center portion of harped strand).

F. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:

1. Report dated June 1973, "An Evaluation of the Vibra-Tension, Model ET-U, an Instrument for Measuring Prestressing Strand Tension".
2. Manufacturer's Literature, "Vibra-Tension Model ET-U".

End of Text (California Test 677 contains 6 pages)

TABLE 1

VIBRA-TENSION SETTINGS FOR DIFFERENT MANUFACTURERS
COMMONLY USED PRESTRESSING STRANDS

Manufacturer	Strand Diameter † (mm)	Unit Weight (N/m)	Scale	Vernier Setting*	Diameter Setting
C.F. & I. Steel	11.11 H	5.836	D	8	186
	12.70 H	7.762	D	6	216
U.S. Steel	11.11 H	5.763	D	8	185
	12.70 H	7.660	D	$6^{1}/_{2}$	214
Bethlehem Steel	11.11 H	5.763	D	8	185
	12.70 H	7.849	D	6	216
Armco Steel	11.11 H	5.690	D	8	184
	12.70 H	7.587	D	$6^{1}/_{2}$	210
Suzuki Steel	11.11 H	5.865	D	8	187
	12.70 H	7.747	D	6	214
Shinko Steel	11.11 H	5.748	D	$8^{1}/_{2}$	185
	12.70 H	7.645	D	$6^{1}/_{2}$	214
Tokyo Rope Steel	11.11 H	5.807	D	$8^{1}/_{2}$	185
	12.70 H	7.587	D	$6^{1}/_{2}$	211
Sumitomo Steel	11.11 H	5.778	D	$8^{1}/_{2}$	185
	12.70 H	7.718	D	6	214

† H = High-strength, 1860 MPa strand.

* Set at zero for non-contact transducer.

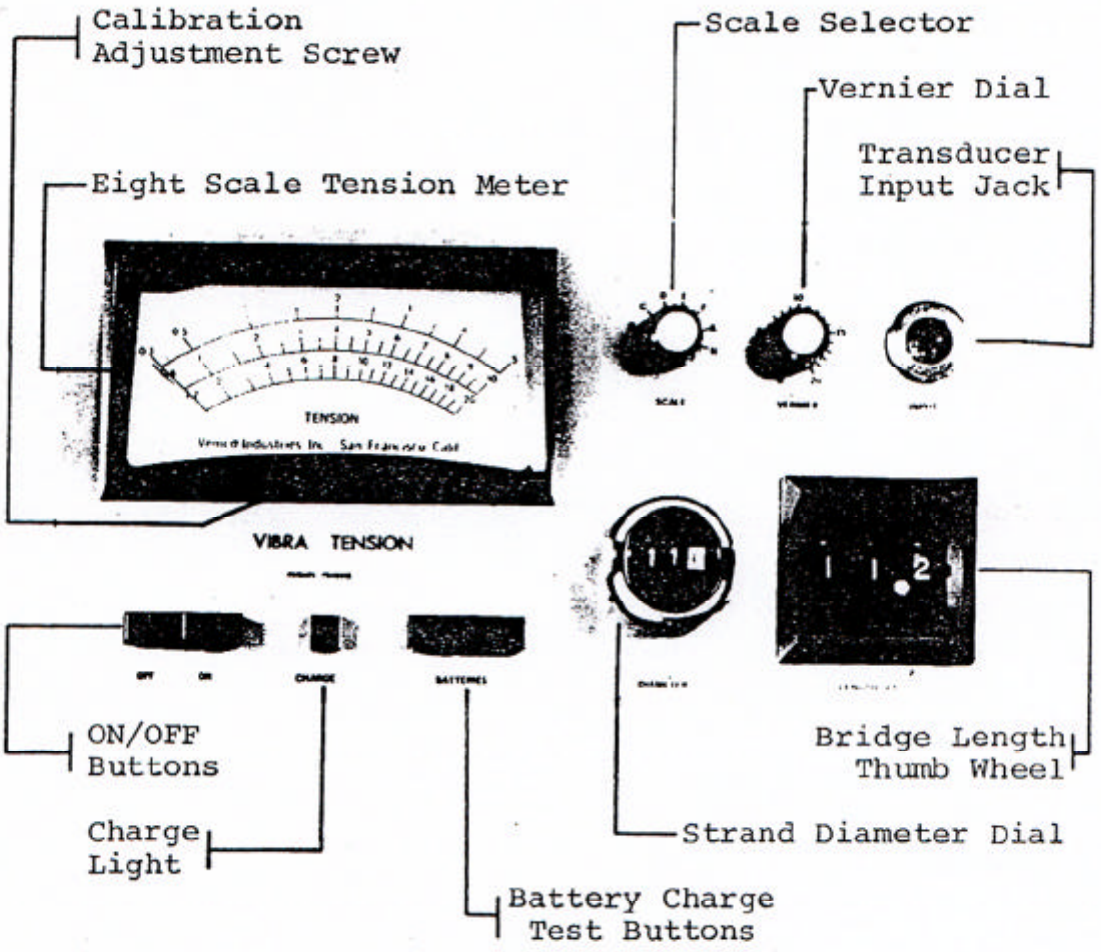

FIGURE 1 - FRONT PANEL OF VIBRA-TENSION, MODEL ET-U

FIGURE 2 - POSITION OF NON-CONTACT TRANSDUCER

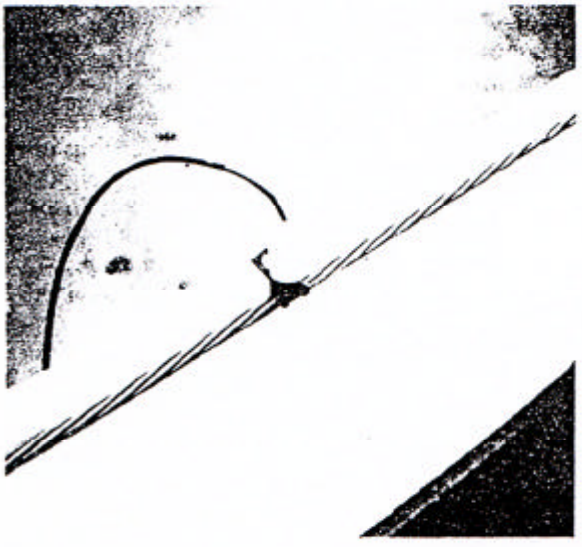

FIGURE 3 - POSITION OF CONTACT TRANSDUCER